Software for Automated Generation of Reduced Thermal Models for Spacecraft Thermal Control

Topic: S3.02 Thermal Control Systems, Project No. NNX11CB02C

Identification and Significance of Innovation

- Thermal models and analysis are extensively used in design and thermal control of NASA spacecrafts and instruments
- Conventional approaches based on general thermal mathematical models with full discretization or simple lumped-parameter models are either computationally prohibitive or inaccurate, leading to prolonged design cycle and imprecise thermal control
- There is a critical need to develop efficient reduction algorithms and thermal models for precise, real-time temperature control and for analysis and design of spacecrafts and instruments at reduced time and cost
- Proposed solution leverages technological advancements in model order reduction techniques, computational analysis, and software development

Technical Objectives & Work Plan

Develop software for automated generation of reduced thermal models for NASA spacecrafts and instruments

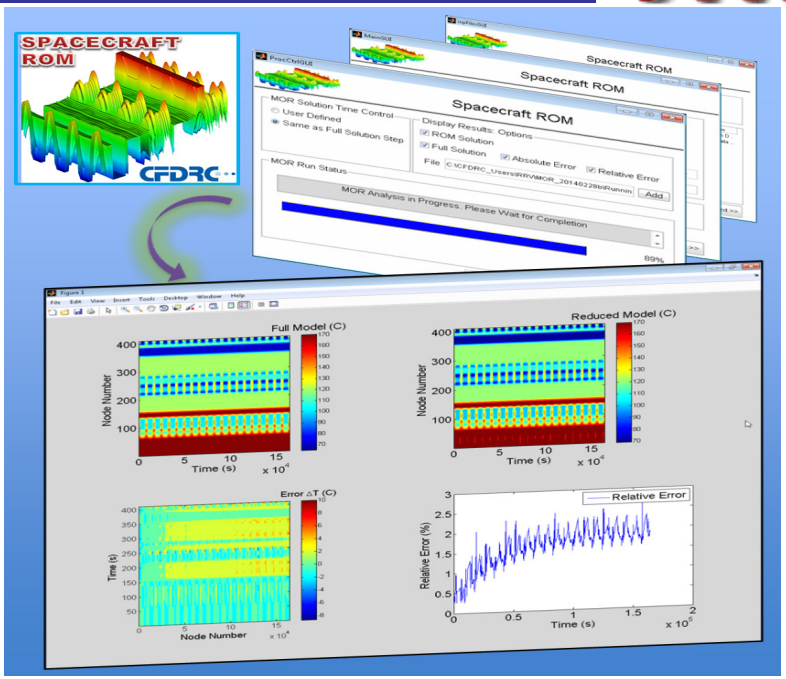
- Develop MOR algorithms to enhance computational performance
- Develop novel MOR capabilities to address complex thermal models
- Develop nonlinear parameterized MOR algorithms for enhanced reusability
- Develop a modular software environment to integrate our MOR software into NASA-relevant thermal analysis tool
- Demonstrate MOR software for thermal analysis of NASA interest

Phase II Accomplishments

All Phase II goals were successfully accomplished, including:

- Various nonlinear equation-based, parameterized MOR methods and equation free algorithms were developed.
- A Differential-Algebraic Equation (DAE) solver was developed to handle large-size equation system
- Developed a modular integrated MOR software environment
- Both equation-based and equation-free MOR libraries were developed and integrated with SINDA/FLUINT to facilitate technology transfer to NASA
- A graphic user interface (GUI) was developed for ease-of-use
- Software validation and technology demonstration using **whole-satellite** thermal analysis: **3-500X** speedup with salient accuracy

Phase II End-product is at TRL 4-5



Current effort enables salient reduction in computational time and resource usage

NASA Applications

- Enable rapid and computationally affordable thermal analysis for better understanding of design spaces as well as design assurance
- Develop advanced, reliable thermal control strategies for spacecraft and instruments
- Properly arrange test procedures for rational use of instruments and facilities

Non-NASA Applications

- Broad industrial applications, including electronics cooling, rapid thermal processing, and other thermal management applications

Firm Contacts

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